STATE OF CALIFORNIA
EARL WARREN, Governor
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
OLAF P. JENKINS, Chief

SAN FRANCISCO | SPECIAL REPORT 10-C | SEPTEMBER 1951

JADEITE OF SAN BENITO COUNTY, CALIFORNIA

By
H. S. YODER AND C. W. CHESTERMAN

JADEITE OF SAN BENITO COUNTY, CALIFORNIA†

By H. S. Yoder * and C. W. Chesterman **

OUTLINE OF REPORT

Illustrations

INTRODUCTION

In view of the considerable interest in jadeite, it is desirable to present some of the preliminary results of field studies made in San Benito County, California, during the summer of 1950. Laboratory work in progress will be included in a complete report at a later date.

The mineral which most nearly approximates the ideal formula for jadeite, $NaAl(SiO_3)_2$, is known from only four other areas: [1] Burma, Japan, Central America, and Celebes.[2] In Burma the jadeite is found in serpentine associated with albite and nepheline; in Japan, in serpentine with albite and quartz; in Celebes, rimming an aegirine-rich pyroxene in a lawsonite-albite-sericite quartzite. The California deposits are the first occurrences in place of jadeite which have been found in the western hemisphere.

The first report of jadeite in California was made by Mielenz [3] in his study of the geology of the southwestern part of San Benito County. He described a quartz-albite-jadeite schist containing lawsonite, glaucophane, garnet, and muscovite. Although this work has not been published, reference was made to his discovery by Taliaferro.[4] In 1950 Bolander,[5] unaware of Mielenz's work, reported the discovery of jadeite in boulders in Clear Creek, San Benito County, about 6 miles east of the area mentioned by Mielenz. Shortly thereafter, discoveries of jadeite in place were announced by several prospectors who had been working the area. Several deposits found in other counties have since been made known to the Division of Mines through the generous cooperation of both amateur and professional mineral prospectors.

† Manuscript submitted for publication January 25, 1951.

* Petrologist, Geophysical Laboratory, Carnegie Institution of Washington.

** Associate mining geologist, California Division of Mines.

[1] Yoder, H. S., Jadeite problem: Am. Jour. Sci., vol. 248, pp. 225-248, 312-334, 1950.

[2] de Roever, W. P., Igneous and metamorphic rocks in eastern central Celebes: Geological explorations in the Island of Celebes under the leadership of H. A. Brouwer, North-Holland Publishing Co., Amsterdam, pp. 65-173, 1947.

[3] Mielenz, R. C., Geology of the southwestern part of San Benito County, California: Univ. California, unpublished thesis, p. 59, 1936.

[4] Taliaferro, N. L., Franciscan-Knoxville problem: Am. Assoc. Petroleum Geologists Bull., vol. 27, pp. 109-219, 1943.

[5] Bolander, L. Ph., Jr., First jadeite discovery in America: Mineralogist, vol. 18, pp. 186, 188, 1950.

GENERAL GEOLOGY

The general geology of the area in San Benito County in which the jadeite is found has been described by Eckel and Myers.[6] The jadeite outcrops lie in an oval body of serpentine, 4 by 12 miles, which is rimmed by Franciscan sandstone and Upper Cretaceous Panoche formation (fig. 1). The major portion of the area is barren of vegetation and subject to frequent rock slides, but most of the outcrops of jadeite are obscured by manzanita, spine grass, briar, and poison oak. The area may be reached by secondary roads maintained by the county; however, the roads may be impassable after a heavy rain.

Eight large exposures of jadeite were found in the canyon of Clear Creek (New Idria quadrangle: N ½ sec. 12, T. 18 S., R. 11 E.) and there are, no doubt, many more. Six of these bodies, completely surrounded by highly sheared and brecciated serpentine, are lens shaped and do not exceed 50 by 200 feet in outcrop. The seventh, a veinlike body, was found at the contact of the serpentine with an enclosed mass of schist. The existence of an eighth body is inferred from the few large masses of float at the contact of another enclosed block of schist with the serpentine, and from the presence of jadeite in the schist near the contact. The locations of the jadeite bodies are given in figure 2. Detailed collections of specimens were made across the jadeite bodies where possible. Although an effort was made to secure representative samples, some outcrops did not yield samples, even to heavy sledging.

Lens-shaped Jadeite Body. One of the six lenslike bodies which were examined in detail is shown in figure 3. The serpentine which completely surrounds this body is sheared into lenticular masses (elongated discoids) whose longest dimension averages about 6-8 inches. Occasional portions of the serpentine may be massive or may be brecciated into small blocks. Each dark-green lenticular mass (antigorite) is usually bounded by an apple-green slickensided surface (chrysotile). In close proximity to a jadeite body the serpentine is extremely sheared, darker in color, the surface dull, and appears to have been altered. Many sinuous, threadlike white streaks (garnet) apparently formed in the alteration process.

The contact zone, not more than 2 feet wide (fig. 4), was weathered out except at one point. The only unweathered contact rock observed is light brown in color, fine-grained, heavy, hard, and tough. The bulk of this rock appears to be grossularite, lawsonite, pumpellyite, and a green amphibole. This type gives way to natrolite and jadeite. An abrupt change in color marks the contact with a rock composed only of jadeite. The jadeite in the contact zone is no doubt quite variable in composition. In many places the contact zone is probably much narrower and may even be absent.

[6] Eckel, E. B., and Myers, W. B., Quicksilver deposits of the New Idria district, San Benito and Fresno Counties, California: California Jour. Mines and Geology, vol. 42, pp. 81-124, 1946.

FIGURE 1. Photograph of typical serpentine outcrop.

The jadeite rock crops out as isolated knobs; although most of it is massive, it is in places blocky, sheet jointed, or cavernous. The most striking feature is the banded character (fig. 5) produced by alternating light- and dark-green layers a fraction of an inch to an inch in thickness. Individual bands, although contorted in a gentle way only, cannot be traced from outcrop to outcrop. Enclosed by the jadeite mass are blobs of natrolite, pectolite, and albite, knots of black talcous material, and small irregular masses of thickly banded shaley rock.

Preliminary work indicates that much of this jadeite contains a considerable amount of the diopside molecule.

Probably many more masses of jadeite will be found in the serpentine, judging by the large number of jadeite boulders in Clear Creek. Most of the jadeite boulders in Clear Creek, some of which are as large as five feet in diameter, probably retain their original shape as bounded in the serpentine; masses of jadeite of similar size and shape probably will be found in place as isolated masses randomly distributed throughout the serpentine.

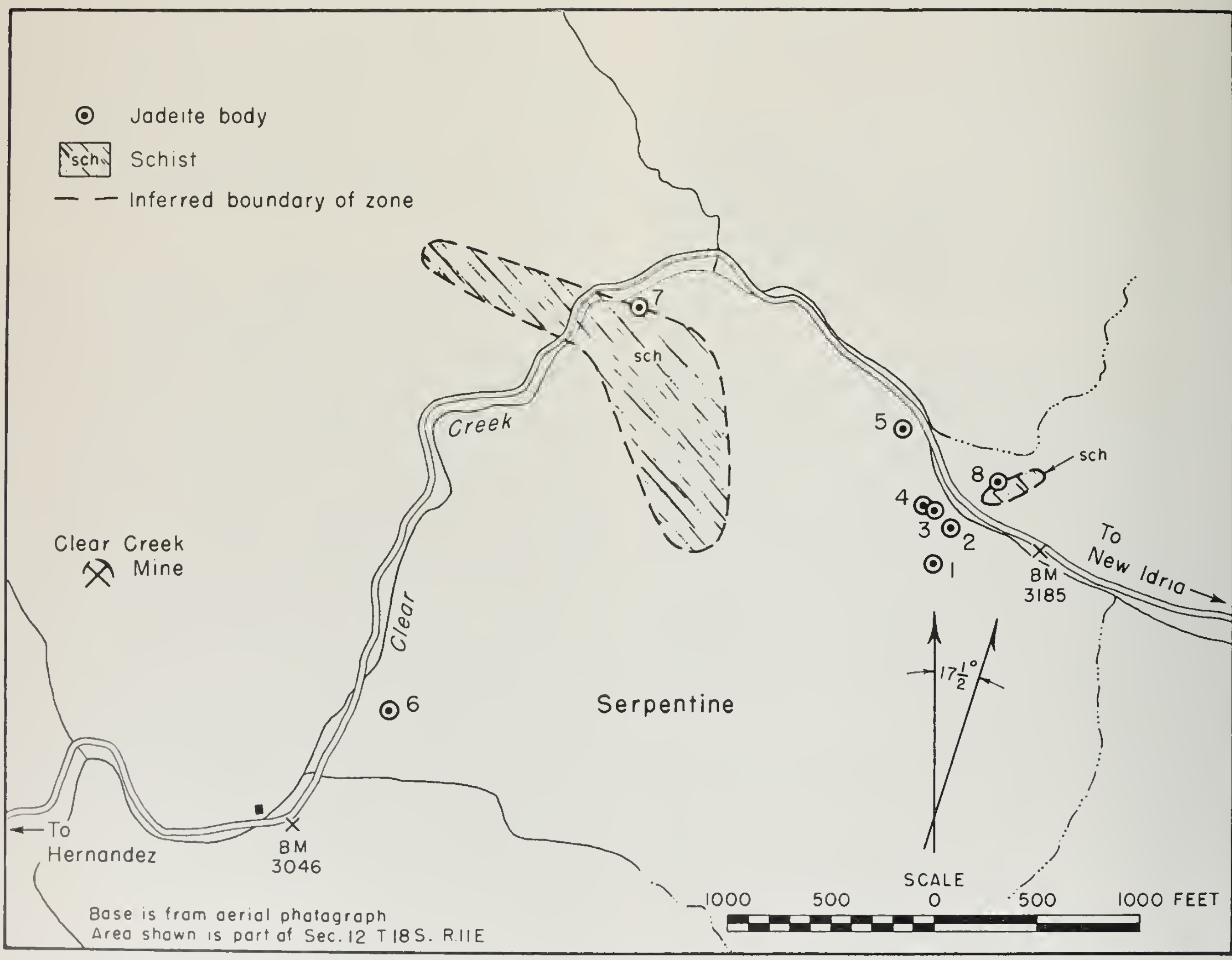

FIGURE 2. Map showing location of jadeite bodies in Clear Creek, San Benito County, California.

Many mono- and bi-mineralic bodies, of which deite is only one representative, lie in the serpentine. asses of comparable size, but mainly of grossularite, opside, natrolite, tremolite, idocrase, or albite, are not ncommon in the serpentine area. All of the bodies, in-uding those of jadeite, exhibit cavities. In the jadeite it ould not be ascertained whether these had been filled and eathered out or whether they were original open cavities.

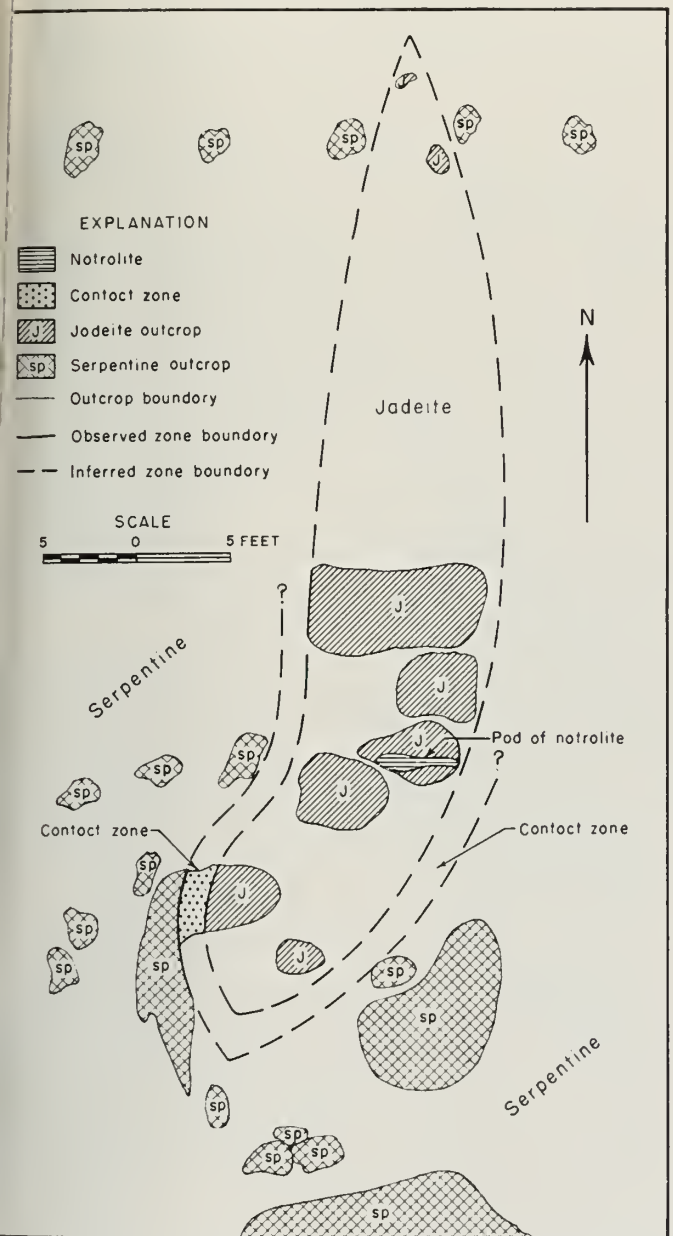

Figure 3. Sketch of outcrops and inferred boundary of lens-shaped jadeite body.

Veinlike Jadeite Body. At the contact of a block of schist in the serpentine lies a different type of jadeite body (fig. 6), a vein traceable for about 50 feet. At one end it appears to be terminated by large masses of jadeite, similar to the first type, which pinch and swell along the continuation of the trend of the vein. A multiplicity of veinlets, roughly paralleling the main vein, lie in the schist. One large branch of the main vein cuts across the schist; no branches were observed to enter the serpentine. Near the contact the sheared serpentine becomes black in color and the surface of the individual serpentine lenticular mass appears glassy. The contact zone against serpentine consists of approximately 3 inches of hard mixed rock of chlorite and contorted and broken ribbons of diopside. Next is found a zone 1 inch thick consisting of chlorite. This soft material is traversed by irregular cracks from which jadeite crystals appear to have grown out into the chlorite.

Figure 4. Photograph of contact zone sketched in figure 3 showing contact zone (C) composed of grossularite, lawsonite, pumpellyite, and green amphibole lying between jadeite (J) and sheared serpentine (S).

The jadeite vein is mostly from 6 to 8 inches wide but pinches to 2 inches in places. It is dark green at the borders and becomes white and coarser grained at the center. There are patches of the white jadeite in the dark-green jadeite and some natural sections give the impression that the white material has been brecciated. Preliminary X-ray work indicates that the white jadeite is exceptionally rich in the jadeite molecule. Considerable analcite and some albite occur in the vein.

Figure 5. Photograph of banded jadeite boulder.

It is not clear from the field data how many stages of jadeite growth took place or what the significance of the apparent brecciation may be. For example, the white jadeite, occupying the center of the vein, is considered to be later than the dark-green jadeite at the vein walls, yet dark-green jadeite encloses patches of white jadeite. There is evidence in one of the lenslike bodies that the green jadeite was crushed and sheared into a flaser structure before the white jadeite was deposited. Further complications were observed in the jadeite masses terminating the vein.

The contact on the albite-actinolite-sericite schist side is marked by soft clayey material; the alteration zone extends for several feet. The veinlets which parallel and cross the schistosity also contain white jadeite and analcite. The main vein and its branches are displaced slightly by many faults which are lined or filled with analcite.

The mass of dark-green jadeite terminating the vein is traversed by many small sharply bounded veinlets of white jadeite and albite. The veins of white jadeite may be as much as 1 inch in width and bear cross-cutting relations with each other in much the same way as the many chrysotile veins cut each other in some serpentines. The crystals usually grow with their long dimension perpendicular to the vein walls but sometimes occur in sprays.

The jadeite masses, similar to those of the first type, are thinly banded and enclose small lenses of neighboring schist. Other contacts of the serpentine with enclosed blocks of schist were examined for similar jadeite bodies but in one other place only was there evidence for the possible existence of a veinlike body.

Mode of Formation. From the field data collected the following mode of origin has been inferred:

1. Serpentine was either emplaced in the solid state or formed by alteration of a previously emplaced pyroxenite.

2. The blocks of schist in the serpentine are either residual country rock or inclusions from depth.

3. Deformation took place either during or after the emplacement of the serpentine. The serpentine acted as a plastic body and the schist as a brittle body. The former is predominantly slipped and sheared, and brecciated only rarely when massive; the latter is highly faulted.

4. The most intense fracturing, shearing, and brecciation, as well as the greatest development of open space, took place at the contact of the serpentine and schist. Many other granulated zones, unrelated to schist, formed in the serpentine.

5. Fluids entered the most highly brecciated, fractured, and sheared zones. These fluids were probably residual from the process which gave rise to the serpentine. This idea is favored in that it is readily supported by laboratory data and there are no other so-called igneous bodies in the area with which the fluids may be associated.

6. The fluids gave rise to many mono- and bi-mineralic bodies in the serpentine of which the jadeite is only one representative.

7. The fluids are presumed to have deposited a diopsidic pyroxene at first and then an almost pure jadeite in the later stages.

8. During the final stages or following consolidation, the jadeite bodies were fractured and faulted to a minor degree. The fractures and faults were then lined or filled with analcite.

From the field evidence, then, it may be tentatively stated that the jadeite formed either during or after the emplacement of the serpentine and that the fluids from which it was deposited were most likely residual from the process which gave rise to the serpentine.

Jadeite has in the past been considered a high-pressure mineral, that is, a mineral which can form only under very high pressures. Recent laboratory experiments[7] led to the conclusion that jadeite was stable not only at low temperatures but even at atmospheric pressure. The occurrence of jadeite in a vein associated with serpentine supports the view that jadeite does not require high pressures for its formation and that it is stable at moderate (less than 500° C.) temperatures.

ECONOMIC IMPORTANCE

The jadeite deposits studied in San Benito County, California, will probably not yield high-quality gem material but will be a source of attractive and interesting specimens for collecting and polishing. There is little doubt that many more deposits of jadeite will be found within the serpentine belt of California. Although similar in color to most serpentine, the toughness and density of jadeite should be adequate clues to the keen prospector.

Other localities in California for which reports of jadeite have been verified by the Division of Mines are as follows:

Williams Creek, Mendocino County	Stream boulders
Valley Ford, Sonoma County	Glaucophane schist
Paso Robles, San Luis Obispo County	Stream boulders
Eel River, near Mina, Mendocino County	Stream boulders

[7] Yoder, op. cit.
Yoder, H. S., and Weir, C. E., Change of free energy with pressure of the reaction nepheline + albite = 2 jadeite: Am. Jour. Sci. (in press), 1951.

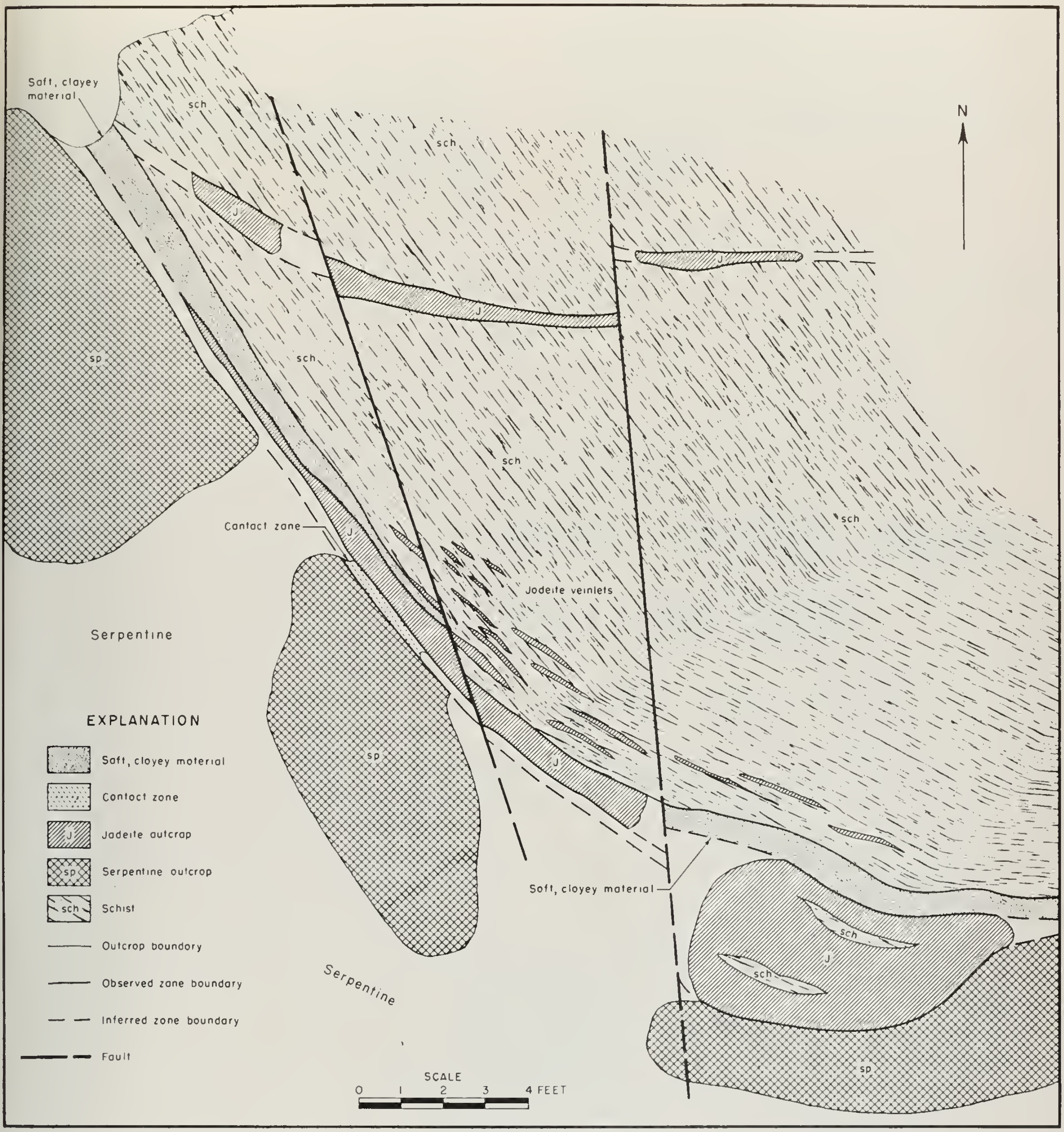

FIGURE 6. Sketch of outcrops of jadeite vein at contact of serpentine with enclosed block of schist.

REFERENCES

Bolander, L. Ph., Jr., First jadeite discovery in America: Mineralogist, vol. 18, pp. 186, 188, 1950.

Chesterman, Charles W., Jadeite in San Benito County, California: Lapidary Jour., pp. 204, 208, 1950.

de Roever, W. P., Igneous and metamorphic rocks in eastern central Celebes: Geological explorations in the Island of Celebes under the leadership of H. A. Brouwer, North-Holland Publishing Co., Amsterdam, pp. 65-173, 1947.

Eckel, E. B., and Myers, W. B., Quicksilver deposits of the New Idria district, San Benito and Fresno Counties, California: California Jour. Mines and Geology, vol. 42, pp. 81-124, 1946.

Mielenz, R. C., Geology of the southwestern part of San B County, California: Univ. California, unpublished thesis, 1936.

Taliaferro, N. L., Franciscan-Knoxville problem: Am. Assoc. P leum Geologists Bull., vol. 27, pp. 109-219, 1943.

Yoder, H. S., Jadeite problem: Am. Jour. Sci., vol. 248, pp. 225 312-334, 1950.

Yoder, H. S., and Weir, C. E., Change of free energy with pre of the reaction nepheline + albite = 2 jadeite: Am. Jour. (in press), 1951.

printed in CALIFORNIA STATE PRINTING OFFICE

42977 4-51 2M